

II.

ON THE TREATMENT AND PLANTING OF SALMONOID FRY.

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In the report of this department for 1895, I published some notes on the culture of trout. My remarks had reference mainly to the procuring of eggs, the process of fertilization, and the management of the ova during incubation. These notes appear to have aroused widespread interest, and in consequence of their publication a large number of attempts have been made by private parties to commence fish-culture, especially the culture of speckled trout or brook trout. From the number of communications which have reached the Department of Marine and Fisheries upon the hatching and rearing of trout, the hope which I ventured to express has been fully realized when I said "there is evidence of a growing desire in various provinces on the part of enthusiastic individuals to pursue private fish-culture, and to second and to support the efforts of the Department of Marine and Fisheries in recuperating various waters in the Dominion."

It is true that in some concluding paragraphs in the report alluded to, I pointed out some of the conditions necessary, not only for the successful incubation of the eggs of the trout, but also for the rearing of the newly hatched fry. I added some details, indeed, respecting the building of ponds, and the steps desirable to guard against enemies of hurtful influences, in short, I pointed out the precautions required in order to ensure the best results.

The four main considerations for success in planting fry are:

(1) The best age at which fry could be planted in order to ensure the largest results.

(2) The season and climatic conditions best for transport.

(3) The places to be selected for planting.

(4) The precautions necessary to be observed when the fry are in transit.

When the hatching of eggs is carried on upon an extensive scale it is very necessary to commence the work of distribution with as little delay as possible. The advent of warm weather brings many dangers which are avoided by planting in the early and colder days.

Newly hatched fish carry on their under side a large bag of food-yolk upon which they feed by a process of absorption. There is danger in handling fry when the sac is large as the delicate envelope or skin outside is very tender, easily abraded and ruptures, causing the death of the fish. It is wise therefore to allow them to remain in the hatching troughs for 10 or 20 days, by which time the yolk-ball has much diminished and the fish are more hardy and robust. There is of course danger from various causes of losing a large proportion of the fry of whitefish, salmon, and trout if they are retained long after the absorption of the yolk-sac. Fungus, which may also attack eggs during incubation, is one of the most pernicious. What is called "dropsy" in the yolk-sac is not common, inflammation or clogging of the gills is frequent, but fungus is an epidemic that often carries off entire batches of eggs and fry.

The commonest remedy is common salt, of which a saturated solution is made, practically strong brine, and this is poured into the tanks containing the infected fish. It is a good plan to turn off the supply tap so as to leave 2 or 3 inches of water in the tank, and it is easy then to convert the contained water into a fluid not quite the strength of sea-water. It must be thoroughly mixed and the fry left in for about half an hour. Usually the bath has no ill effect; but if the fry appear to be becoming weak or discomforted, the fresh water should be turned on again. A bath of this kind has been found beneficial, though it requires care, as young salmon.

immersed in sea-water too long die from hardening of the yolk-sac, which becomes dense like india-rubber. Recently another remedy has been advocated, viz., permanganate of potash, which sweetens the water and destroys organic germs. The *Revue Scientifique* notes that at the Geneva Exhibition, 1896, permanganate of potash was used to clean the aquarium, and it is claimed that it prevented the specimens of the salmonidæ from being attacked by *Saprolegnia*. It is a matter, however, of experiment as yet, and further trials are necessary to establish its success.

One recent experimenter tried a new method and with a small painter's brush or the thumb and finger, removed the fungus, and then with a solution of 18 grs. of bichloride of mercury diluted in a 6 oz. bottle, he applied with a camel-hair brush this solution over the parts affected, holding the fish a few seconds before returning them to the water, which was changed daily. The result, he states, is that after one application his fish entirely recovered, with but a few exceptions, which however, were cured by a second application.

There has been much controversy respecting the merits of planting small and helpless fry and planting yearlings or fingerlings, which have been kept in ponds and fed on artificial food. It is admitted that great loss results when fry are thus impounded, and the trouble and expense are serious if a great quantity of fry are being reared. Some of the best pisciculturists (like Mr. F. Francis) have advocated turning the fish out at once i. e., just before or at the time they begin to feed. The strongest argument in favour of this course, apart from the loss by death and the saving of time, money and labour, is that derived from the contention that fry if kept in artificial inclosures and fed become semi-domesticated after a few months and, when liberated amongst their wild companions already in their streams and lakes, fall victims either to starvation (from inexperience in foraging for food), or to predaceous enemies (from which they have been from the hatching stage carefully guarded). Very young salmon and trout attack their weaker brethren and artificially reared "yearlings" certainly do not commence free life on equal terms, with those reared by nature. There is much therefore to be said in favour of using all haste in planting these fry in suitable places after hatching and before the yolk is entirely absorbed. "They do not want any food" said Frank Buckland "for they are supported by the contents of the umbilical vesicle and at this time above all others require protection. You may at this time increase the flow of water, for I have discovered from painful experience, that water which is sufficient for a given number of eggs is not sufficient for the same number of young fish, when they come out of the eggs." It is, however, a fact that young fry frequently take food, and swallow small particles before the yolk sac has been entirely absorbed. As a rule the yolk has gone before the 35th or 40th day after hatching. If the yolk sac is half-absorbed, say on the 20th day, the fry may be safely planted. They have sufficient food to last them until they are thoroughly accustomed to their natural surroundings, and are able to shift for themselves.

The cool and favourable weather of April, May or early June, unless the season be later than usual, is adapted for distribution, and the risks of loss at that time from long or tedious journeys is reduced. Such long and perilous trips are as far as possible to be avoided; but they are often necessary in order to reach the shallow upper waters which are most suitable for planting the young fry.

The question has often been discussed whether fry whose incubation has been protracted are stronger than those which have been hatched earlier under a higher temperature. Certainly the mortality in broods of English trout hatched in water below 40° F. is far less than when the water is of a higher temperature. The same has been found to be true of the Canadian speckled trout and the Rainbow trout.

In a series of ova which had reached an advanced stage in water of 48° F., and were then placed in trays supplied with water 10° lower, the hatching out did not take place until the 120th day, though they are known to hatch in 50 or 60 days under a higher temperature. The resulting fry are more robust, and fewer die during the early stages after liberation from the egg than in those hatched at a tem-

perature of 48° to 60°. Actual tests on spawning beds have shown that for long periods the water may not rise above 34° or 35° until April, and the period of hatching is therefore prolonged to 150 or 160 days, with the result that the fry are stronger and more healthy.

In accordance with the conditions which obtain in nature, the fry, after exclusion from the egg, should not be subjected to very low temperatures, but water ranging from 45° to 55° is most suitable. The carrying of fry to the localities where they are to be deposited is an important matter. Railway journeys, if not too protracted, do little harm to fry, unless the cans or tanks holding them are kept too near a stove or hot coils. Excessive heat often proves fatal in railway cars, but as a rule, journeys by rail are less perilous than by team over rough roads, when the shocks and collisions seriously disarrange the delicate organization of the young fry, and damage it is believed the sensitive otcysts of the little fish. Team-drives over rough trails through forests are not conducive to the well-being of fry, and when possible, cans should be carried, in the matter described later, over very rocky or uneven tracts. Conveyance by boat or canoe is by far the best mode. Cans specially contrived for the purpose are best, and should be made of heavy galvanized iron* or stout iron well tinned, and holding 10 to 12 gallons of water. They may be 24 or 26 inches high, and say 18 inches in diameter, but may be of the form of a truncated cone, with a narrow neck in the centre for the purpose of preventing the splashing and loss of water as far as possible. Into the neck (say 6 inches in diameter), a cylindrical can fits, the bottom of which is made of fine metal gauze. The gauze not only allows of aeration, but when necessary serves as a receptacle for pieces of ice, which, melting, trickles into the water below in which the fish are swimming about. The ice is often broken up into fine pieces or crushed, if it does not melt and cool the water properly. It should always be remembered that the young of fishes, above all salmonoid fishes, cannot endure heat, nor are they able to withstand frost with impunity. Indeed, ice placed in the lid of the can or tank has proved harmful when on warm days the fry have been surrounded for some hours by water of 50° or 60°. Hence the advisability of transporting young fish either in the early spring months or during the night, and at early morning when the season is warmer and more advanced. At such times they can be most safely shipped.

It is well known that newly hatched fish are far less hardy than eggs. But even eggs during the first few weeks are very sensitive, and within three weeks after fertilization they should be subjected as little as possible to concussions and rough usage. Salmon eggs 22 days old died in 8 or 9 days after being roughly handled during some experiments by the late Dr. Francis Day, the well known British salmon authority, but after the 47th day only very hurtful causes, such as chemical impurities, &c., will do them any harm, and "eyed" eggs are hardy in the extreme. No doubt vast numbers of ova are lost every year at the head waters of salmon rivers by being frozen. Certainly in 1881 this loss was very severe on many Scottish rivers. The famous physiologist, Dr. Davy, brother of Sir Humphrey Davy, imbedded salmon eggs in ice, and found that they survived; but his experiments provided conditions probably more gradual than the severe and trying circumstances of freezing near the source of a river.

In order to keep the cans suitably cool an outside jacket of iron is often provided, separated by an empty space from the inside can containing the fry. Such double cans are very effective, and being much cooler than ordinary cans the fry are shipped in them with much greater safety and success. Whitefish fry which are very small and delicate will to the number of 15,000 to 25,000, travel in one of these cans without loss if the journey be not long and trying; but half that quantity of brook trout and salmon would as a rule suffice. Some authorities favour the wise principle of putting a minimum quantity of fry in each can and regard 3,000 to 5,000 as ample, but with newly hatched fry before the gills are properly developed,

* While galvanized iron is the best material, it must be remembered that the spirits of salt, used in soldering is very hurtful, and new cans, should stand full of water (often renewed) for eight or nine weeks.

and before they have acquired their full larval activity and vigour a greater number can be safely shipped in each can. Ten cans is a full shipment for one team, and fewer cans are in most cases advisable. At the famous Howietoun fish-ponds in Scotland, the lamented Sir James Gibson Maitland, whose recent death all interested in fish-culture must deplore, used a conical form of can 24 inches in diameter across the bottom, and 4½ inches in diameter at the top. The height of this can is 32 inches and the weight, when filled, about 170 pounds, so that two men could easily lift it about by means of two strong handles fixed at points a little above the centre of gravity (about 14 inches from the bottom). When it is necessary to convey the cans along forest paths or across rocky hills, two poles are horizontally attached to the handles, and the can is then easily carried—one man walking in front and the other behind. Many Scottish lakes situated on the highest altitudes have been successfully stocked by this method.

All fry should be planted immediately after arrival. If the hour of arrival at the planting ground be midnight or during the small hours of the morning so much the better, the atmosphere is then cool. In any case no time should be lost as every moment is of importance, and the sooner the fry are disporting themselves in the clear waters of the stream or creek the greater is the assurance of success. Under no plea whatever should fry be kept in the cans over the night. Great risk is run by a few hours' delay. If through the impossibility of obtaining a team or other cause it is absolutely impracticable to at once plant them they should be constantly watched and fresh water splashed in, or the water aerated by a bellows or other means. Aeration is most easily and effectively done by lifting up water in a dipper from the can and letting it fall again with a splash: but on no account should the device be adopted by blowing down a tube into the can with a view to aerating the water. Such an absurd plan has been actually adopted by some manipulators: but in blowing down poisonous air from the lungs, the water in the can already vitiated with carbonic acid gas, becomes more vitiated and poisonous. The surest way of killing and asphyxiating fish suffering from lack of oxygen is to blow air from the mouth into their midst.

Again, fry should not be unduly knocked about or the cans roughly handled. "Fry will not stand much knocking about," wrote the late Sir Gibson Maitland the bottom of a tank (or can) used for transporting fry should be stiffened by cross pieces soldered underneath, as, if it sags at all, the fry soon get fatigued, possibly because the least spring from the bottom frightens them and they exhaust their strength by frequent and aimless sallies through the water." The same author also wrote, "With care fry can be carried for twenty-four hours: but the result is not satisfactory if the journey be longer."

Of course small quantities of fry can be sent further and more easily than large. The re-aeration of the water is a difficulty. It cannot be done automatically, as is the case with yearlings, because the motion the water acquires tires out the fry. In fact, the object of filling the tank well in to the cone of zinc is to check the motion."

It usually suffices in a long journey to change the water at appropriate intervals. The fact is well known that little salmon and trout, only 2 or 3 weeks old, actively wave their pectoral fins to and fro and thus create a current of water which aids in oxygenation, and facilitates the breathing operations of the fish.

The actual planting of the fry is a most important matter, and a good deal of very inappropriate advice has been published upon this matter.

It is clear that fry should not be suddenly transferred from a warm can to a can of water that is several degrees higher in temperature than the lake or stream.

The temperature should be somewhat equalized by mingling the two waters before the fish are emptied out. The temperature of the water into which the fry are to be transferred should not be more than 6° higher or lower than the water in which they have been carried from the hatchery.

It is hardly necessary to say that if fry are being sent some distance to be planted, it is an advantage to have all arrangements for their reception made before hand, so that teams may be waiting the arrival of the cans and an immediate start be made. Before placing the cans on the team it is advisable to remove the ice from

the covers of the cans unless the outside atmosphere be very warm. Cans of fish should never stand in the hot rays of the sun: but a cover or sheet should be so placed as to shield them. Cans should also be thoroughly rinsed and cooled with water before fry are placed in them. Fish frequently become sick before leaving the hatchery because this rule has not been observed and the fry placed in cans which have been warmed by the sun or nearness to a stove.

It is a good principle to find out where the fish naturally spawn in the waters to be planted, or if no fish of the same species occur, to ascertain where the best natural conditions exist. Thus whitefish should always be planted on clean gravelly ground in fairly shallow water, or where reefs of honeycomb rock extend. Brook trout and salmon should be placed near the head of streams or as far up tributaries of large rivers as possible, avoiding, however, those which dry up in summer.

Lake trout do best if distributed over rocky shoals such as are selected by the parent fish. In such places as those specified there is abundance of shelter, and the small fish, as a rule, make at once for niches in the rocks, or the protection of pebbles and stones. As pike, pickerel and other predacious fish are in the spring, occupied in spawning, there is less danger from these fish than is commonly supposed, especially as the first-named are then in weedy, marshy localities engaged in depositing their eggs. If sunfish, shiners, small suckers and pike appear to abound, it is best to select some other areas which are free from these destructive pests, or if that is not possible drive these fish away by disturbing the water, sweeping a net over the ground or some such method.

It is often the case that neither time or circumstances will admit of reaching the best and most appropriate localities, and the planting must be done where it is apparent the young fry would not have been under natural conditions found. After much experience with young fry, I am bound to confess that planting fry upon what may not appear the most suitable grounds results in better success than might have been anticipated. The charge often made against officials of merely dumping in the fry at the most convenient rather than the most suitable places is less grave than might be imagined by the inexperienced. A man standing on shore with one foot, encased in a fisherman's boot, in the water, can pour the fry gently into a deep part near the edge, and the fry will immediately seek shelter. A better plan is to gently empty the fry from a boat and the fry disperse before they reach the bottom. For a few minutes the mass of young fish appear to crowd together and then spread themselves and disappear from sight. That they survive and do well admits of no doubt as the remark, already made, applies in this case, viz., that the chief enemies of the young fish are in swampy shallows engaged in depositing their spawn. In thus favouring the planting of fry in deep water where it is a matter of difficulty to plant them in small batches in shallow water, I have the support of the late Sir Gibson Maitland who wrote: "At first we used to place the fry in the shallowest water near the inlet of the ponds; but they were so frightened that they used to be huddled together in masses.....when poured into deep water they instantly disperse, and in a few minutes have spread all over the pond in a lively and inquisitive spirit."

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